Space Weather Technical Forecast

Issued on Saturday, 04 June 2022 at 13:11 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Active Electron Fluence. Chance of G1-G2/Minor to Moderate Storm intervals late Day 2 or Day 3 (5th-6th) from possible CME arrival(s).

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been Very Low, with no significant flares during the period. There are four numbered sunspot regions on the disc, and two further very small new and unnumbered regions. AR3024 (Cso/Beta) in the southwest has stabilised during the period after earlier development, although like AR3027 it has a reverse magnetic polarity to that expected for a SC25 southern hemisphere sunspot region. However, despite this flaring has not yet been observed from either region. All other regions are small and simple. One CME has been observed from a filament lift off in the northeast quadrant. It is too early to fully assess this, but it is likely to be too northward directed to have a significant Earth directed component.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1, has been at background levels through the period. Wind speed has varied between 280-300 km/s. Density has been mostly average. The total interplanetary magnetic field strength, Bt, has been weak at 4nT or below, with the north-south component, Bz, varying weakly between +/- 3nT, but largely in the negative direction. Phi angle was predominantly negative (towards the Sun). Geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) has been at background levels. The high energy electron flux (greater than 2 MeV) has been at High levels, reaching a peak of 9720 pfu at 03/1515 UTC. Electron fluence has been above the Active threshold throughout on a slight rising trend, reaching 4.23e8 integrated pfu at 04/0000UTC.

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is expected to be Low to Very Low, with a chance of C-class flares and only a very slight chance of M-class flares.

Solar Wind / Geomagnetic Activity: There are two potentially Earth-directed CMEs, although both are low confidence. Both are due to filament eruptions, occurring around 01/0100 UTC and 02/0530 UTC. The first is slower and weak, expected to pass late day 2 at around 05/1800+/-12 hours, and the second whilst faster is mostly off the Earth-Sun line with a glancing impact possible around 06/0000 +/-12 hours. These could also potentially combine to give a single arrival. Aside from the CMEs, no other solar wind enhancements are indicated, with mainly background winds expected. Geomagnetic activity is forecast to be predominately Quiet, but increasing to Unsettled to Active late day 2 and day 3 (5th and 6th) should any CME arrivals occur. These will also give a chance of isolated G1-G2 Minor to Moderate storms, mainly with any magnetic cloud on day 3 (6th).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is expected to be at background levels during this period. High energy electron flux (greater than 2MeV) is likely to continue at mainly High levels days 1-2 (4th-5th), but with peak values falling and dropping out with any CME arrival later day 2 or day 3 (6th). Some recovery in values is

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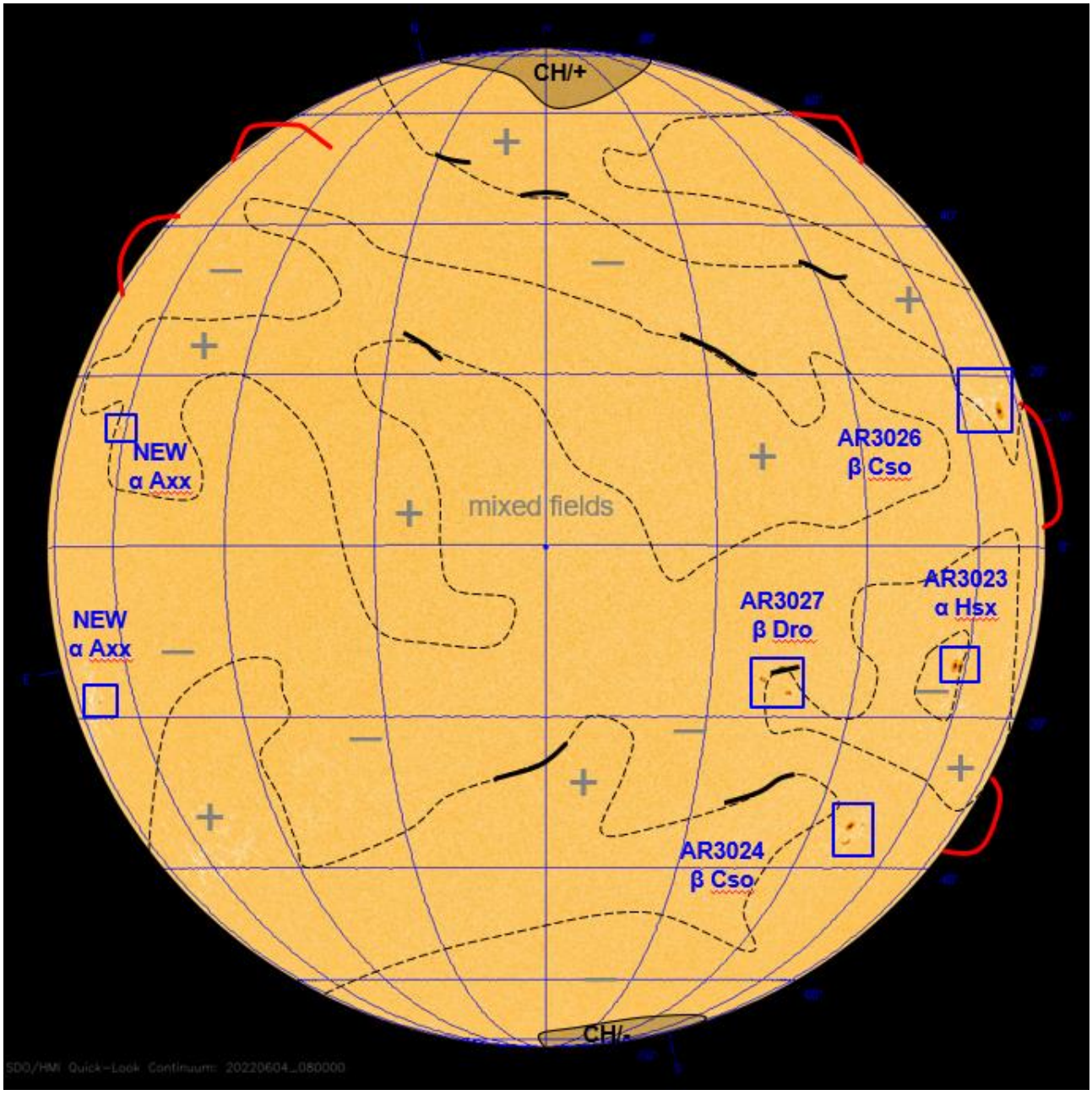
possible day 4 (7th), potentially to high, however this is low confidence. The associated 24 hour fluence is expected to persist at Active (above 1e8 integrated pfu), but potentially falling below later day 3 (6th) in response to any dropout that occurs from any CME arrivals, and otherwise with a gradually decreasing trend.

Figure 1. Solar Analysis Valid 04/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A filament lift-off was observed from the centre disc around 01/0100 UTC, with an associated coronal dimming. A weak CME was produced, which has been assessed as a slow CME, giving a slight chance of a glancing blow late day 2, around 05/1800UTC +/- 12 hours. A further filament eruption sourced CME was also observed leaving the southwest disc around 02/0530 UTC. This has the potential for a glancing blow around 06/0000 UTC +/- 12hours. Both CMEs are low confidence, however there is also the potential for a combined arrival, increasing the potential for a geomagnetic response, most likely with any magnetic cloud moving through on the 6th.

Aside from the CMEs, background wind speeds are expected to persist through the period with no notable coronal hole fast wind enhancements expected.

Geomagnetic activity is forecast to be predominately Quiet, but increasing to Unsettled to Active late day 2 and day 3 (5th and 6th) should any CME arrival occur. These will also give a chance of isolated G1-G2 Minor to Moderate storms, mainly with any magnetic cloud on day 3 (6th).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	20	30	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
01/1300	Partial	Filament	4N 10W	252 km/s	15/1800 +/- 12 hrs	Limited shock, weak and low confidence.
02/1315	Partial	Filament	6S 45W	525 km/s	06/0000 +/- 12 hrs	Glancing impact possible. Low confidence.

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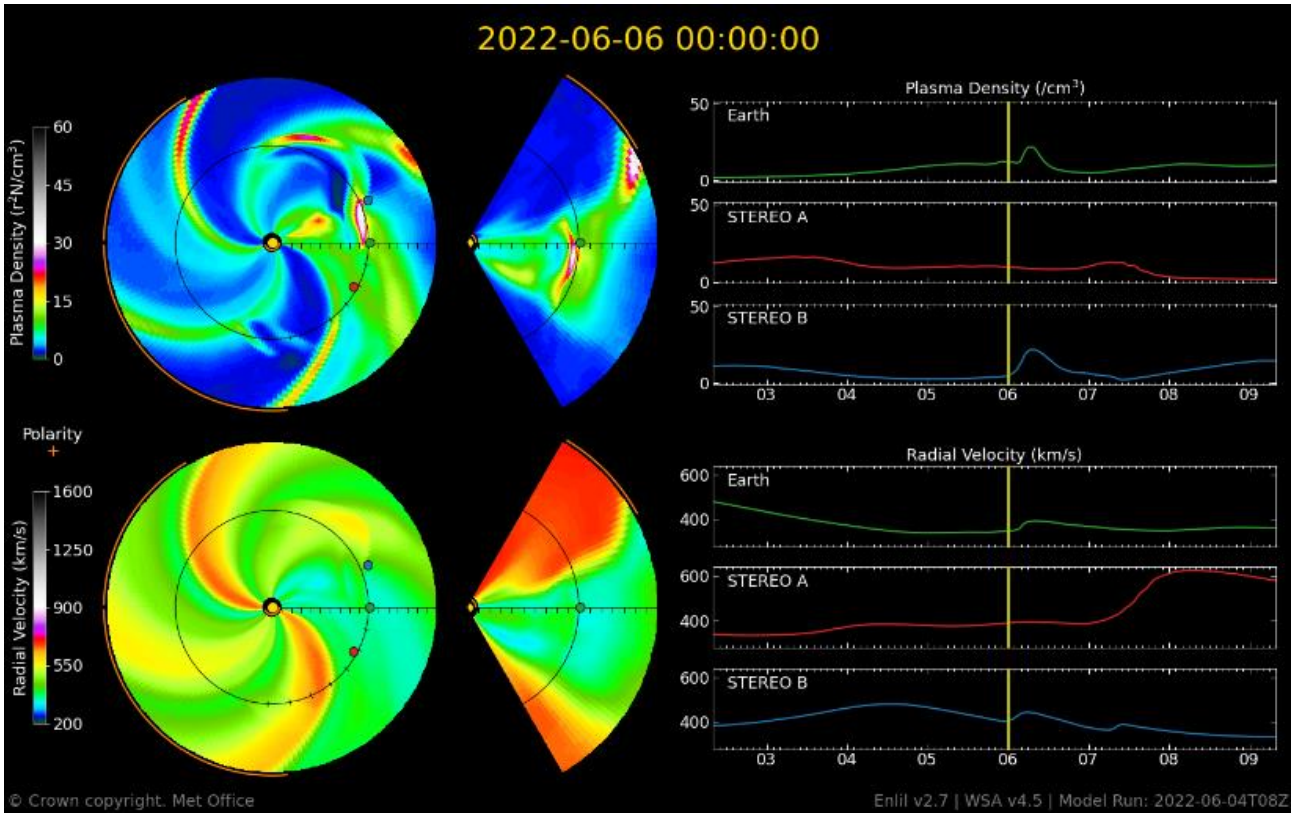
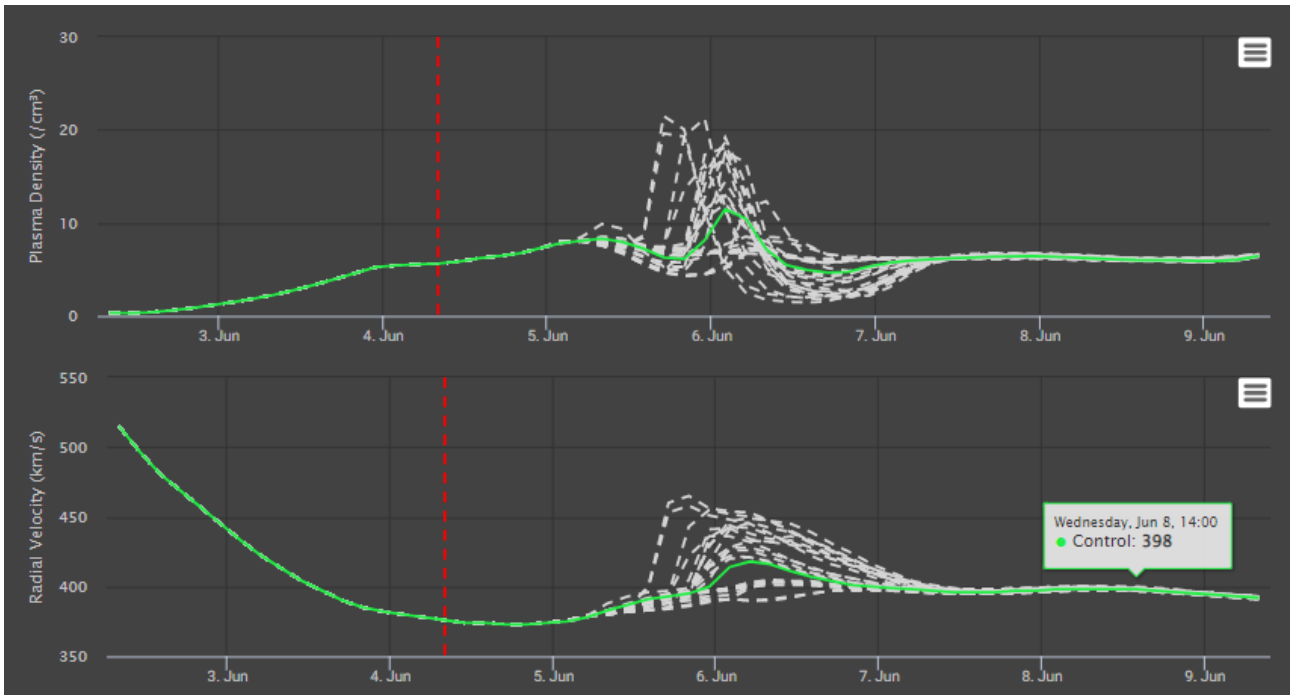
Figure 2: Enlil model and ensemble suggesting a most likely combined CME arrival at 06/0000 UTC, but with a large variation, and low confidence.





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Radio Blackouts - X-Ray Flares:

Solar activity is currently Very Low with no notable flares in the past 24 hours. This is despite four numbered sunspot regions on the disc.

AR3024 (Cso/Beta) was showing development, but has recently stabilised. However, this has seen the emergence of reverse polarity spots (for southern hemisphere in SC25) very close to the original mature unipolar spot. It remains a small spot however, with no flaring observed, so it remains to be seen how much this will affect the stability of the region. AR3027 (Dro/Beta) is another reverse polarity southern hemisphere region, but remains small and stable, whilst AR3026 (Cso/Beta) is now approaching the northwest limb and appears to be stable. The final numbered region AR3024 (Hsx/alpha), has remained simple and stable, whilst two further very small Axx/Alpha regions are now present in the east of the disc.

Activity is currently expected to remain Very Low, with a chance of rising to Low, and only a very slight chance of M-class flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	5	5	5	5
Very Active	R3 to R5 X Class	No	1	1	1	1

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is at background levels and is expected to remain at this level through the period.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	1	1	1	1
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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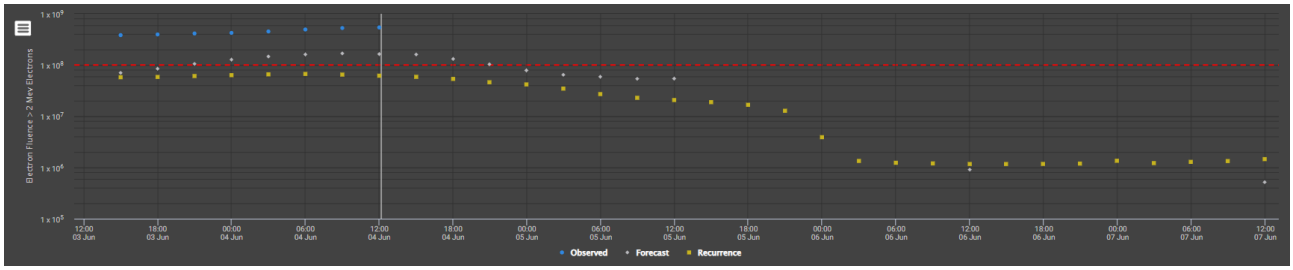
High Energy Electrons Event (≥ 2MeV):
The high energy electron flux (greater than 2MeV) as observed by GOES-16 has been at High (greater than 1000pfu) levels through the last 24 hours due to the fast wind enhancement that occurred a few days ago. With no further notable solar wind disturbances affecting Earth through to Day 3 (5th), these mainly High levels are expected to persist, albeit with declining peak values. The potential arrival of two CMEs late day 2 or day 3 (5th or 6th) is then likely to cause levels to drop out, before a recovery to Moderate to High levels day 4 (7th).

The associated 24 hour electron fluence is currently Active (greater than 1e8 integrated pfu) and is expected to persist at this level into day 3 (6th). Confidence then falls for continuing Active levels into day 4 (7th), due to the potential drop out of flux that occurs from any CME arrival, along with an uncertain recovery following. Observed fluence is currently running much higher than REFM expectations, and consequently expected to remain well above the REFM forecast.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	Yes	100	100	60	30
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 3: REFM is underestimating the fluence levels, and is also expected to be reducing fluence levels too quickly.



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